

MATHEMATICS

The Mathematics Archives Outreach Program: A Program of Dissemination and Education about Mathematics on the Internet

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DUE-9550943
FY 1995 \$ 100,000
Mathematics

The Internet is becoming an increasingly fertile source for information and tools of use and interest to the mathematics community. These resources range from programs and class notes to data sets for statistics and discussions of timely topics vital to the mathematical community. Many persons who would benefit from these resources are unable to do so because of a lack of knowledge of what is available and a lack of understanding of how to access items on the Internet. Based on experience with the Internet in establishing and running the Mathematics Archives, this project is informing the mathematical community about available resources on the Internet and educating them on how to access those resources. This is being accomplished by presentations at sectional meetings of the MAA and running special sessions, workshops, and minicourses at national and regional meetings, such as those of the MAA/AMS, AMATYC, and ICTCM. The impact of this program on the mathematical community is expected to be substantial.

A Modular Interactive Text for Linear Algebra

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DUE-9455618
FY 1995 \$ 199,914
Mathematics

Mathematics educators from Grinnell College, The University of Washington, and Seattle Central Community College are developing an interactive linear algebra text. The text is organized in clusters of individual modules to facilitate its adaptation to many different curricula. The goals of the project are: (1) to help students develop their geometric intuition about the concepts of linear algebra; (2) to deepen their understanding of the algebraic formulations of these concepts and strengthen their ability to manipulate them; and (3) to help students gain an appreciation of how the concepts and methods of linear algebra are applied. The text is constructed using *Maple V*, enhanced by a supplementary package with superior text-handling and screen-layout capabilities. The text is designed to support collaborative learning and writing to learn. Many exercises encourage experimentation and exploration and ask for written hypotheses and conclusions. The entire text is being made available through the Mathematics Archives and will be readily available to all by *ftp* and *gopher*, and through the World Wide Web. In addition to being appropriate for all students majoring in science, engineering, and mathematics, the text is appropriate for students preparing for careers as secondary school mathematics teachers and is being tested with preservice teachers at all three institutions.

Teaching with Original Sources in Mathematics

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DUE-9354330
FY 1994 \$ 67,204
FY 1995 \$ 21,570
Mathematics

This project is developing an innovative lower-division mathematics course based on the study of original mathematical texts. The course provides an introduction to mathematics by examining the evolution of selected problems that fueled the development of several branches of mathematics. This class serves as a general education course for students in any major who have a solid high school mathematics background and provides a stimulating alternative to the standard mathematics course offered to liberal arts majors.

Mathematics Without Calculus

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DUE-9455305
FY 1995 \$ 204,386
Mathematics

Faculty are producing, evaluating, and disseminating an interdisciplinary mathematics course for students whose major does not require calculus. Many of the ideas from calculus, such as rates of change, are included. The goals are to provide students with an appreciation of the intrinsic worth of mathematics, expose them to real applications of mathematics, and empower them with the quantitative and qualitative skills necessary for analytical and mathematical reasoning. The course is not to be a broad survey of either mathematics or its applications; rather, it focuses on a few significant and timely applications of mathematics provided by professions from agriculture, biology, business, chemistry, engineering, music, physics, political science, and zoology. A key feature of the course is the implementation of modern technology to provide students with fundamental tools such as graphical analysis, which have broad applications and allow a diminished role for traditional drill and calculation. One product of the project will be a commercially published text.

Principles and Practice of Mathematics

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DUE-9354509
FY 1994 \$ 192,851
FY 1995 \$ 157,956
Mathematics

A two-semester introduction to the principles and practice of mathematics is being developed for students who wish to study a significant amount of mathematics, including majors and minors in mathematics, computer science, and many science and engineering disciplines. This course, designed as an alternative to the standard calculus sequence route into the mathematics curriculum, stresses breadth, and includes many of the areas of modern mathematics and applications that are currently "homeless" in the mathematics curricula. The design, review, field

testing, and production of the course are being overseen by an advisory/editorial board and author team with a wide range of mathematical expertise and writing experience. Extensive outreach efforts include regular mailings, presentations at professional meetings, and faculty enhancement workshops. The project will culminate with the dissemination of materials by a major textbook publisher.

Development of a Course Sequence in Fractal Geometry for Interdisciplinary Undergraduate Education and Increased Mathematics and Science Literacy

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DUE-9455636
FY 1995 \$ 203,562
Mathematics

This project is building on the inherent interest in fractal geometry by creating materials for a series of three fractal-based undergraduate mathematics courses: an introductory pre-calculus course emphasizing concepts, visualization, and interdisciplinary connections, particularly to art, music, philosophy and economics; a post-calculus course presenting the same material at a deeper mathematical level; and an upper level course on the applications of fractals and chaos including a detailed examination of data analysis and modeling. All courses make extensive use of computers in lecture demonstrations and in student homework. Platform independent graphics software is being developed to facilitate this program. Detailed instructor lesson plans are being developed and tested.

Chance: Current Studies of Current Chance Issues, Phase II

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DUE-9354592
FY 1994 \$ 99,969
FY 1995 \$ 109,945
Mathematics

This project is developing a course called Chance that introduces probability and statistical ideas in the context of issues reported in the daily press such as the use of DNA fingerprinting in the courts, the possibility of power lines causing cancer, the methods used to test for AIDS, and the interpretation of political polls. Students read accounts of current Chance issues in newspapers and scientific journals, and give their own critical analysis before discussing the issues with faculty.

To assist others in teaching a Chance course, a bi-weekly Chance newsletter that abstracts current Chance issues in the news is available by e-mail. Previous issues of this newsletter and other materials useful for teaching a Chance course are maintained on a Chance database on the Internet available by gopher and through the World Wide Web.

Evaluation of the Chance course uses a statistical reasoning assessment survey developed by Clifford Konold as part of the NSF-funded ChancePlus Project. The survey is given to students at the beginning of the course and again at the end of the course to show how attitudes and abilities related to statistical and probability reasoning have been changed. In addition, students are given,

at the beginning and the end of the course, a newspaper article to read and a series of questions to answer to measure the impact of the course on the students' ability to read the news critically.

The Chance course has been taught at Dartmouth College, the University of California, San Diego, the University of Minnesota, Princeton University, Spelman College, Grinnell College, and Middlebury College. This second phase of the project is continuing development of the Chance database and preparing a teachers manual. The course will be discussed at national meetings and will be the subject of a workshop to identify other schools interested in testing the materials by teaching the course.

State University of New York (SUNY) Pre-Precalculus Program: Empowering Underprepared Two- and Four-Year College Mathematics Students

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DUE-9455638
FY 1995 \$ 184,393
Mathematics

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The State University of New York (SUNY) Pre-Precalculus Project is aimed at a large and growing number of mathematically underprepared and/or unmotivated students, particularly women and minorities, at both two- and four-year colleges. These students did not succeed in mathematics courses in high school and continue to fail to achieve in similar courses such as introductory or intermediate algebra at the college level. To address their needs, this project is developing a new approach to pre-precalculus. It features a revamped curriculum involving contextual problem solving, an integrated use of technology, an improved pedagogy emphasizing active, collaborative efforts by students and faculty, and authentic assessment tied more closely to the course and "real world" skills. A series of curriculum development workshops over a two-year period is addressing these issues. The goal of the project is the design of a sequence of two four-hour pre-precalculus courses and the compilation of the instructional materials to support them. These two courses are replacing all developmental college mathematics courses prior to precalculus. A coalition of 12 SUNY two- and four-year colleges are site testing developed materials over the two-year period. Student assessment is through portfolios, projects, presentations, papers and concept maps. A National Advisory Board is overseeing the development of course and curriculum materials. The model and materials developed by the project will be disseminated throughout the SUNY system and nationally through papers and presentations at professional mathematics conferences.

Curriculum and Pedagogy Reform at Two-Year Colleges: Moving Beyond Myths to Standards

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DUE-9255850
FY 1993 \$ 80,515

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FY 1994 \$ 10,175
FY 1995 \$ 34,320
Mathematics

The recent focus in the mathematical community on calculus and the development of the National Council of Teachers of Mathematics Standards for K–12 teachers is providing a framework to consider mathematics courses taught at two-year colleges, and lower-division mathematics courses taught at other institutions of higher education in this country. These courses are important elements in continuum and pipeline issues, as well as general mathematical needs of students not continuing in mathematically oriented fields of studies. The American Mathematical Association of Two-Year Colleges (AMATYC) is undertaking a leadership role in designing a framework for systemic reform of college mathematics in the curriculum leading to calculus. The first stage is a meeting of an AMATYC National Steering Committee consisting of leaders of AMATYC and other mathematical societies actively involved in the development of innovative mathematics curricula and standards, particularly at the undergraduate level. In the second stage, a small National Task Force is being convened to establish guidelines for the development of a set of standards for two-year college and lower-division mathematics and to formulate a plan to build consensus for mathematics reform among two-year college and university constituencies. These standards are being disseminated and discussed at national meetings of the mathematical societies and revised based on feedback from this community.

Progressive Precalculus Problem Sets for High School and College

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DUE-9354741
FY 1994 \$ 43,277
FY 1995 \$ 54,871
FY 1996 \$ 51,852
Mathematics

This project is developing progressive problem sets and innovative classroom exercises for use in high school and college precalculus classrooms. These materials present concepts from various points of view, emphasize writing, use technology where appropriate, encourage the use of collaborative learning, and stress the application of mathematics to other disciplines. Compatibility with current innovative calculus curricula, guidelines presented in the National Council of Teachers of Mathematics Standards, and current research on the ways people best learn mathematics are being used to evaluate the problem sets as they are developed. The materials consist of homework and in-class problems, as well as complete solutions and suggestions for use. The problem sets are being pretested as they are developed; workshops for both college and high school teachers, designed to demonstrate the materials and generate feedback, are being held; and a year-long piloting project is being conducted that involves at least three four-year colleges, one community college, and nine high schools.

Mathematical Interactive Network Design (MIND): A Computer Lab for Developmental Mathematics

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DUE-9455606
FY 1995 \$ 75,394
Mathematics

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The Mathematical Interactive Network Design (MIND) Project is a computer laboratory designed for *adaptive* interactive multimedia in developmental mathematics. The project uses SIMPLE, a new authoring system designed by Drs. Marion Hagler and William Marcy of Texas Tech University utilizing Visual Basic techniques. With object-oriented programs developed by supervising instructors, students use a graphical user interface and icon-driven software to access and work with the various instructional media. The goal is to immerse students in an intensely interactive, but easily constructed, simulated learning environment. This project provides a supportive environment for developmental students who, according to previous studies, derive few benefits from a computer tutorial session based upon a typical drill and practice structure. MIND meets each student's specific needs by providing individualized tutorial sessions with appropriate, constructive, instructive, and timely feedback. This system includes a "computer guide" whose behavior and even personality can be made to adjust to the attributes of the learner and demands of the instructor. The guide monitors all student activities and directs the tutorial session in a manner statistically indistinguishable from an experienced teacher. The guide presents various combinations of interactive video, audio, graphics, and text. This combination provides the students with choices of lecture, practice problem solving, and review and testing as deemed necessary.

This guide-driven tutorial session platform is being used as the basis for a two-year project to develop and implement tutorials for Basic Algebra I and begin development of tutorials for Basic Algebra II. It is being monitored by an advisory board. When the Basic Algebra I tutorials are completed, they will be tested at Amarillo College and Blinn Community College. Evaluation will be a qualitative analysis of the system by the student users and teachers and also a quantitative analysis to see if there has been statistically significant improvement in the completion rate.

A Capstone Course in Statistics

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DUE-9455292
FY 1995 \$ 29,960
Mathematics

This project establishes a prototype capstone course to synthesize mathematical, statistical, and computing lessons learned throughout the curriculum and to develop students' oral and written communication skills to the level expected of professional statisticians. The synthesis is achieved by having teams of students participate in eight inexpensive laboratory experiments emphasizing concepts of applied and mathematical statistics, mathematics, and computing. They also study technical writing and oral presentation modules and prepare formal written and oral reports. If a report is not of professional quality, the student is given considerable feedback and required to repeat the report. All students leave the course with a firm understanding of the communication skills required of the professional statistician. All course materials are reviewed by members of an evaluation team consisting of an academic statistician, an industrial statistician, a professor of speech and a professor of technical writing. The evaluation team will also review the written reports and videotapes of the oral presentations.

Computer Supported Cooperative Learning Environment for Multivariable Calculus

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DUE-9455672
FY 1995 \$ 100,000
Mathematics(LLD)

Computer laboratory projects are being introduced in all sections of the basic multivariable calculus course at the University of Michigan (1500-1700 students per year). The computer is being used as a discovery tool. The project's main features are: promotion of active learning and hands-on experience; visualization through computer graphics; gradually introduced *Maple* syntax; furtherance of conceptual understanding; critical thinking; and quantitative reasoning. Several activities are included in the project: developing a library of laboratory projects (long term—each project is to culminate with a problem applied to science, economics or engineering); developing and implementing cooperative learning techniques in the computer laboratory environment; developing and implementing motivational material suitable for feedback techniques in large lecture classes, using a workstation in every classroom connected to an LCD panel; writing TA and instructor manuals and videotapes; and creating an intensive TA and faculty training program. All materials are being written with the consideration that some students have no prior computer experience.

Mathematical Sciences: Geometry of Configurations, Polygons, and Polyhedra

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DMS-9300657
FY 1993 \$ 30,000
FY 1994 \$ 30,000
FY 1995 \$ 30,000
Mathematics

The project involves investigations in the fundamental geometry of convex polytopes, configurations, and combinatorial aspects of symmetries. Applications are proposed for tiling patterns in a variety of contexts including architectural design and stereoscopic viewing. Another component of the project entails an undergraduate education activity in aspects of geometrical structure. The project is developing further instructional material in several areas of geometry suitable for students at the high school and junior college level. Activities for participation of teachers at these levels are also being carried out.

Teacher Preparation Archives Second Printing

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DUE-9455577
FY 1995 \$ 6,900
Mathematics

From August 1991 to April 1993, CIRCE (the Center for Instructional Research and Curriculum Evaluation) at the University of Illinois executed a contract with the National Science Foundation under the title "Teacher Preparation Archives: Case Studies of NSF-Funded Middle School Mathematics and Science Teacher Preparation Projects." The funding of the nine campuses to develop exemplary programs for middle school teacher preparation was a singular effort on the part of NSF. This unique program highlighted both middle school education and teacher preparation. That project culminated in a report entitled "Teacher Preparation Archives: Studies of NSF-Funded Middle School Science and Mathematics Teacher Preparation Projects," by Robert Stake, James Rath, Mark St. John, Deborah Trumbull, David Jenness, Michele Foster, Sherry Sullivan, Terry Denny and Jack Easley. Targeted both for a general and specialist teacher educator audience, the report runs over 300 pages as a paperback book. An additional 1,200 copies are being printed for distribution to requestors, with advertising handled through mathematics, science, and middle school education organizations.

Mathematics Concentrations in Economics and Chemistry

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DUE-9455972
FY 1995 \$ 25,000
Mathematics

This project is designed to enrich mathematics courses at all levels of the curriculum by incorporating applications to and perspectives from economics and chemistry, and to enhance the teaching of mathematical methods in economics and chemistry courses. In the first year of the project, development of curricular materials is being undertaken at Haverford and Princeton in economics and at the University of Chicago in chemistry. Development and dissemination of these materials is catalyzing formation of two coalitions, one for mathematics and economics and one for mathematics and chemistry. This project is developing sample materials which can later be expanded into a project for national impact. The project involves close interdisciplinary cooperation, participation of graduate and undergraduate students, and team-teaching through faculty sabbaticals. In particular, a workbook incorporating sophomore mathematics (multivariable calculus, linear algebra, and differential equations) with its applications to chemistry is being written by interdisciplinary teams for widespread dissemination.

A Planning Seminar for Faculty Participating in the Rollins College Quantitative Learning and Teaching Program

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DUE-9456000
FY 1995 \$ 25,000
Mathematics

Faculty from nine different departments in mathematics, the sciences, economics, politics, and business are working together to establish interdisciplinary initiatives involving teaching and learning of quantitative skills. In the last two years, with support from the Bell South Foundation, participating faculty have gathered and studied materials on quantitative problem solving, have created instructional guidelines, established a resource center, brought in experts as consultants to address the faculty, established two computer-based classrooms, hired an instructional specialist to work with faculty, and recruited the first group of students to work with faculty on the project. An important component of this project is a summer seminar for faculty. This seminar series is being extended throughout the academic year to enable a larger number of faculty to participate, with the goal of extending participation to faculty in all departments.

Library for Interactive Studies in Mathematics

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DUE-9551273
FY 1995 \$ 249,998
Mathematics(LLD)

This project addresses the problem of how to use new information technologies, in particular the World Wide Web on the Internet, to make new tools available to teachers, to encourage the use of those tools to enrich the quality of mathematics instruction at the undergraduate level, to more effectively reach larger sectors of the student population, and to expand pedagogy with new technology-supported styles of teaching and learning. The project strives to make existing interactive materials easily available, to extend them, and to create new materials focused on the level and the abilities of the students users. The Library for Interactive Studies in Mathematics and Science, based at the Institute for Academic Technology of the University of North Carolina, Chapel Hill, is being built on the World Wide Web over a two-year period. The library contains interactive workbooks on topics commonly encountered in undergraduate mathematics, from college algebra and pre-calculus through multivariate calculus, differential equations, and mathematical modeling. The library makes available to instructors all over the country a wide variety of interactive workbooks that they may freely use and distribute to their students. Workbooks, together with the program necessary to read them, are provided over the Internet instantly, and free of charge. The initial library holdings are 45 of the most effective experimental workbooks created for the MAA-sponsored Interactive Mathematics Text Project (funded by IBM and NSF, ILI-LLD grant USE-9150272). All needed information about the library is disseminated electronically via e-mail and discussion lists, as well as through presentations and workshops. The goal is to show teachers what can be done, to get them interested in experimenting, and to teach interested faculty how to build their own interactive workbooks. Faculty are invited to join an initial core group of eight knowledgeable authors whose colleges are participating by piloting and testing materials. Materials are provided and a workshop is being held to prepare 16 new teacher/authors. An integral part of the development process is feedback from an editorial board directed to the authors.

Calculus, Concepts, Computers, and Cooperative Learning: Assessment and Evaluation in Terms of Dissemination Goals

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DUE-9450750
FY 1994 \$ 113,080
FY 1995 \$ 104,920
Mathematics

This project is engaging in assessment, evaluation, and research to determine the effects of calculus reform curriculum and dissemination activities from the previously supported Calculus reform project at Purdue University. Assessment activities are related closely to research into how students learn mathematical concepts and include studies of the role of the teacher as facilitator and the use of group learning. The current dissemination approach includes the preparation of an instructor's resource manual, workshops, and the continued growth and development of a network of implementers. A model is being developed for evaluation of student attitudes, performance, and conceptual understanding in comparison with students who took calculus in standard models.

Bridge Calculus Consortium Based At Harvard

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DUE-9352905
FY 1994 \$ 141,847
FY 1995 \$ 381,112
FY 1996 \$ 299,212
FY 1997 \$ 299,135
Mathematics

The Calculus Consortium based at Harvard University, has developed, tested and disseminated an innovative single variable calculus course. The course is currently being used at over 125 colleges around the country and abroad. Information about the Consortium's single variable materials has reached a large number of faculty at diverse institutions. The effort is now being expanded to include precalculus and the second year of calculus. The dissemination effort for this phase is being modeled on the workshops, minicourses, newsletters, test sites, and networking that have proved successful in disseminating information about the single variable calculus course.

Revitalizing Introductory Statistics for Engineering by Capitalizing on Interdisciplinary Cooperation and State-of-the-Art Technology

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DUE-9455578
FY 1995 \$ 57,866
FY 1996 \$ 92,134
Mathematics

A novel laboratory approach is being developed for the instruction of introductory statistics for engineers, with emphasis on problem solving, conceptual understanding, and the use of writing and calculation-and-plotting as acts of cognition. Through interdisciplinary cooperation, a closer link between statistics and engineering courses is being made for a great benefit to both. Finally, taking advantage of the capacities made available by state-of-the-art computing and multimedia technology, curricular resources are being developed that will increase students' interest, motivation, and excitement.

Gateways to Advanced Mathematical Thinking: Linear Algebra and Precalculus

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DUE-9450731
FY 1994 \$ 236,029
FY 1995 \$ 273,177
FY 1996 \$ 272,978
Mathematics

This project is building on previous research and curriculum development work to develop flexible understandings of topics in precalculus, calculus, and linear algebra. Exemplary course materials are being produced using a modular approach to package the concepts and activities. Based on broad mathematical themes, these materials make use of constructivist pedagogies, involving cooperative learning, computer technology, and alternatives to traditional lecturing. Field testing of the curriculum provides sites for research into the way students learn the topics and environments for teacher enhancement.